

AD \_\_\_\_\_

MIPR NO: 92MM2583

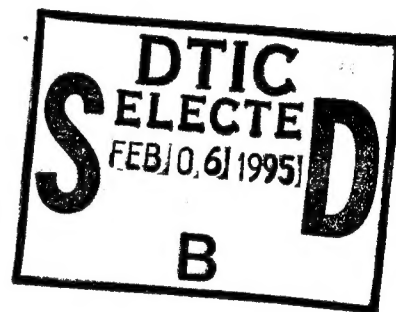
TITLE: ANALYSIS OF WOUNDS BY EVAPORATIVE WATER LOSS IN MAN

PRINCIPAL INVESTIGATOR: Sharon L. Hammond

CONTRACTING ORGANIZATION: Fitzsimons Army Medical Center  
Aurora, Colorado 80045-5001

REPORT DATE: September 21, 1994

TYPE OF REPORT: Final Report



PREPARED FOR: U.S. Army Medical Research and Materiel  
Command, Fort Detrick  
Frederick, Maryland 21702-5012

DISTRIBUTION STATEMENT: Approved for public release;  
distribution unlimited

The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision unless so designated by other documentation.

19950201 023

# REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank) 2. REPORT DATE **September 21, 1994** 3. REPORT TYPE AND DATES COVERED **Final (6/1/92 - 7/31/94)**

4. TITLE AND SUBTITLE **Analysis of Wounds by Evaporative Water Loss in Man** 5. FUNDING NUMBERS **MIPR No. 92MM2583**

6. AUTHOR(S) **Dr Henry C. Jefferson, Dr Samuel Cucinell, and Dr Sharon L. Hammond**

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Fitzsimons Army Medical Center  
Aurora, Colorado 80045-5001** 8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) **U.S. Army Medical Research and Materiel Command  
Fort Detrick  
Frederick, Maryland 21702-5012** 10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT **Approved for public release; distribution unlimited** 12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)  
**Cytokine growth factors are known to increase wound healing in animals and may be found to soon have an impact on human wounds, wound infections, and debridements. In order to assess the impact of these factors one must first establish a quantitative method of measurement for wound healing. This protocol's intent was to devise such a method using evaporative water loss otherwise referred to as Transcutaneous Water Evaporative Loss (TWEL). We attempted to apply an evaporimeter to assist in the measurement of TWEL. Patients entered into the study were those who had undergone recent breast biopsies with TWEL readings taken immediately after the biopsy and approximately 5 additional readings at clinic visits once a week. Data thus far, however, has been noncontributory to the analysis due to multiple difficulties with the evaporimeter and establishing a method for using the evaporimeter in this type of a wound healing process.**

14. SUBJECT TERMS **CIC3, Wound Healing, Analysis, Water** 15. NUMBER OF PAGES **WHO QUALITY INSPECTED 8** 16. PRICE CODE


17. SECURITY CLASSIFICATION OF REPORT **Unclassified** 18. SECURITY CLASSIFICATION OF THIS PAGE **Unclassified** 19. SECURITY CLASSIFICATION OF ABSTRACT **Unclassified** 20. LIMITATION OF ABSTRACT **Unlimited**

## FOREWORD


Opinions, interpretations, conclusions and recommendations are those of the author and are not necessarily endorsed by the US Army.

Where copyrighted material is quoted, permission has been obtained to use such material.

Where material from documents designated for limited distribution is quoted, permission has been obtained to use the material.

 Citations of commercial organizations and trade names in this report do not constitute an official Department of Army endorsement or approval of the products or services of these organizations.

In conducting research using animals, the investigator(s) adhered to the "Guide for the Care and Use of Laboratory Animals," prepared by the Committee on Care and Use of Laboratory Animals of the Institute of Laboratory Resources, National Research Council (NIH Publication No. 86-23, Revised 1985).


 For the protection of human subjects, the investigator(s) adhered to policies of applicable Federal Law 45 CFR 46.

In conducting research utilizing recombinant DNA technology, the investigator(s) adhered to current guidelines promulgated by the National Institutes of Health.

In the conduct of research utilizing recombinant DNA, the investigator(s) adhered to the NIH Guidelines for Research Involving Recombinant DNA Molecules.

In the conduct of research involving hazardous organisms, the investigator(s) adhered to the CDC-NIH Guide for Biosafety in Microbiological and Biomedical Laboratories.

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

 30 Dec 94  
PI - Signature Date

## **TABLE OF CONTENTS**

- I. Introduction**
- II. Hypothesis**
- III. Body**
- IV. Conclusion**

## I. INTRODUCTION

Cytokine growth factors have been known to increase wound healing in animals. Their impact on human wounds is still under investigation. In order to assess the impact of such factors is platelet derived growth factor, transforming growth factor, and epidermal growth factor, one must have a reproducible and reliable method of quantitative wound healing. Previous attempts at analyzing surgical wounds failed for want of a good methodology. Refer to the following study entitled "Platelet Derived Growth Factor in the Healing of Stab Wounds" a pilot study HSC90263.

Reviewing wound healing, one notes that it is divided into 4 phases - coagulation, inflammation, proliferation, and remodeling. Coagulation requires platelets, fibrinogen, and fibrin. There is no method however that measures coagulation phase of healing and there is none proposed. The inflammatory phase is the entrance of the inflammatory cells into the wounds and it is associated with capillary formation, increased blood flow, swelling and erythema. There have been several proposed clinical methods for measuring this phase to include doppler, plasmagraphy, skin tensiometry, and infra-red thermography. The third phase - proliferative phase incorporates new collagen which adds strength to the wound. In animals there is increased breaking tension. Clinically this is a time that sutures are removed. Near infra-red reflectance spectroscopy detects a specific bond through collagen and holds great promise for measurement of this and other phases of healing. The fourth phase - the remodeling phase continues long after clinical concerns for the wound. The epithelial keratinosis and the tangle mesh of subcutaneous collagen reorganizes threads and cords along the stress line. Healing graft donor site and blisters epithelization are measures of remodeling. The stratum corneum forms and transcutaneous water evaporative loss returns to normal.

It is this measurement of TWEL which we are exploring. TWEL is inexpensive, harmless, and may be a precise method for wound healing measurement. Animal studies using TWEL show that it may reflect wound healing. Its greatest benefit is its non-invasive nature. TWEL is calculated in  $\text{gm/m}^2/\text{h}$ . TWEL is influenced by atmospheric physiologic variables damage to the stratum corneum and some diseases. The instrument used to determine TWEL is the galvanic skin resistance, the ventilated chamber, and the evaporimeter. The evaporimeter is an open cylinder with light reflecting temperature controlled mirror. Under computer control the mirror is cooled to the dew point at which point the light reflectance drops. This dew point is used to calculate the TWEL. This device is sensitive to ambient relative humidity but is fast and reproducible. The commercial evaporimeter has a circular detector which must be modified for linear wounds. Ideally, only the wounds should be included in the sensor and no normal skin. Water evaporates continuously from non-sweating normal skin at

the rate of 38.7 plus/minus 12.5 in the palms to 7.7 plus/minus 2.3 g/m<sup>2</sup>/h on the forearms of humans. Intra-individual differences are 30 and 10 percent. TWEL returns to control exponentially ( $t_{1/2} = 4.5$  days) which could be accelerated by semi-occlusive dressing.

## II. HYPOTHESIS

The hypothesis of this study was that water loss from the healing surgical wound would give consistent TWEL measurements with time. This was pilot methodology study. The plan was that patients who underwent common surgical wound procedures would be entered into the study. Two such groups were identified to include patients with inguinal hernias as well as patients who underwent breast lump biopsies. The inguinal hernia was selected because the surgery was common and presented with patients with wide range of ages. The breast biopsy was selected because it is also a common procedure and can be analyzed soon after the surgery. In addition to these patients 20 additional patients were to have been entered who underwent punch biopsies in the dermatology clinic. The measurements were to be taken over the surgical wound and skin. One and two centimeters away from the wound on both sides. The measurements would be repeated at each data collection session until standard deviation is established. Measurements would be taken in the same room with TWEL meter. Attempts would be made to maintain the room temperature and the humidity, which may have a significant affect on TWEL. The data would be analyzed in a descriptive statistic fashion of continuous variable. Measurements would be taken until a mean and standard deviation was established for each individual at each session. It is estimated that 6 readings at 5 minute intervals will be needed and that the measurement sessions would continue at each clinic visit about once week until TWEL reached baseline which was believed to be around 20-30 days. It was felt that determinations in 10 patients in each wound group would give 90-95% confidence intervals with a width about the mean of 1 standard deviation.

## III. BODY

Patients were entered into the study only in the breast biopsy group. Approximately 3 different patients were entered into the study. None however were able to complete the study. Primarily because of patient dissatisfaction with return after a relatively benign minor procedure. The initial difficulties will be outlined as follows: As noted in the introduction one must have a well controlled environmental room for operation of adequate TWEL measurements. This could not be obtained in the environment in our facility. We did select a room for this equipment that would be the standard room for all measurements. We could not however control the environmental humidity or temperature. Therefore our readings were inconsistent and widely

variable. In addition to the environmental constraints we had difficulty in the actual application of the evaporimeter to the patient. It is a cumbersome piece of equipment and was difficult to apply to the patient in the area required. Again providing no reliable data with the measurements. The third difficulty was actually procuring the instrument initially. Since it is entirely experimental, its design is not commonly used within the research community. It was our interpretation that this instrument has been used to assess evaporative loss in soldiers in the field but has never been applied in this fashion to wound healing. There was difficulty in obtaining the instrument and having it function appropriately as well as difficulty in educating the physician in the use of the equipment. These 3 main obstacles barred any useful data from being obtained.

#### **IV. CONCLUSION**

Wound healing is a important area of research and the attempts at the use of the evaporimeter for quantifying wound healing though unsuccessful provided important data on methods that should probably not be explored in the future. This however does not negate the fact that were one to develop a more user friendly evaporimeter or other instruments for this purpose that such research would not be extremely useful.